VERMICOMPOSTING OF ORGANIC WASTES –
NEW ZEALAND DEVELOPED WORLD LEADING TECHNOLOGY

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Introduction

100% pure New Zealand. Not only does this widely known phrase epitomise the pristine New Zealand environment, it also describes the upcycling of hundreds of thousands of tonnes of organic waste into high quality soil conditioners and fertiliser using vermicomposting technology at industrial scale – a process developed in New Zealand.

Intensive agriculture, horticulture, and forestry on New Zealand's young volcanic soils can be quite challenging when it comes to environmental effects – current controversy surrounding the development of new irrigation schemes in both the North and South Islands is an example. Soils with low humus content and shallow root zones are exposed to drought with the risk of low productivity and also contribute to the high nutrient leaching towards ground and surface waters.

But now scientists in New Zealand have taken the 600,000,000 year old vermicomposting technology to an industrial scale. They have designed, and are operating, the world's largest worm farms and are currently upcycling approximately 150,000 tonnes per year of organic wastes from various industries and communities. 100% pure (earthworm) vermicast is being produced and demand is growing from the primary sector.

Fibrous wastes from wood processing industries usually have a wide C/N ratio, which limits land utilisation unless significant nutrients are co-applied, such as mineral fertilisers (Vasconcelos and Cabral, 1993) with various risks on soil and water ecosystems (Bostan et al., 2005). Municipal biosolids (sewage sludge) have to meet certain stabilisation (pathogen reduction) requirements and require staying below certain contamination limits (metals and organics) (NZWWA, 2003) prior to land utilisation. Both measures have economic disadvantages and as a result New Zealand is currently not land applying, but land filling, the majority of its municipal biosolids.

Vermicomposting is one of nature's most effective and most advanced methods of processing organic wastes – a fact well known by students in many of our primary and intermediate schools. The challenge of up-scaling vermicomposting processes from operational scales of a couple of tonnes of organic wastes per day, to more than 150,000 tonnes per year, has been solved during the last five years and seen it become the most cost-effective up-cycling technology available in New Zealand. The successful operations in the central North Island have raised international interest and the technology is now ready to be taken offshore.

Vermicomposting Technology

Vermicomposting of various industrial organic wastes has been studied for almost five decades (Edwards and Neuhauser, 1988). In earlier publications, paper wastes with a C/N ratio of up to 200 were used as a carbon rich blending agent for nutrient rich wastes such as biosolids, food wastes (Edwards, 1988), manure (Arancon et al., 2005), and other industrial wastes (Tucker, 2005).

A decade later solids from pulp and paper mills (Butt, 1993; Elvira et al., 1996; Elvira et al. 1997; Lazcano et al., 2008; Hoffmann et al., 1984) were used as carbon rich fibre for blending in vermicomposting.

Vermicomposting of solely paper wastes or pulp and paper solids, without adding external nutrient rich wastes, has not been done commercially so far. But, for the first time in New Zealand, lake weeds have been successfully trialed as a nitrogen source for mixing with pulp mill solids by Quintern (2009).

Industrial scale vermicomposting of municipal biosolids, organic wastes from food processing industries, and pulp and paper mills has been presented and published in

New Zealand (Skeer at al., 2013) and recently internationally, by Quintern et al. (2013).

Studies at lab scale were first carried out in 2007 to assess the feasibility of combining various nutrient rich bio-wastes with the pulp mill solids from pulp mills in central North Island. The challenges of these early studies were to:

- Keep the worms happy to feed on the wastes and breed successfully.
- Avoid nitrogen and metal leaching as much as possible.
- Produce a high quality vermicast that would meet the criteria for an Aa grade of the Biosolids Guideline.
- Understand what might be required to up-scale it from lab to industrial scale.

Field trials which began in 2007 have allowed us to:

- Measure data under 'real' conditions for adjusting laboratory results.
- Adjust the trials to meet environmental criteria.
- Produce a vermicast that would pass the Aa grade criteria of the New Zealand Guidelines for Biosolids – though the vermicast is technically not regarded as biosolid any more.
- Produce sufficient vermicast to conduct initial trials on beneficial use on crops and pasture.
- Demonstrate the environmental effects to regional and district councils for lodging resource consents.
- Convince Western Bay of Plenty to become our first region to go full scale for a limited period of time.

Vermicomposting Operations

Since 2008 the organic waste intake has risen from 3,000 tonnes per year to 150,000 tonnes per year. Over the same period the worm population has grown from a few thousand to a calculated 1,200,000,000.

Currently two industrial scale operations are operating; one near Kawerau with a 20 ha footprint and another near Tokoroa with a 35 ha footprint. Local councils, including Rotorua and Hamilton have diverted their total biosolids production from landfill to these worm farms. A small onsite community-based worm farm has also been established recently at the new waste water treatment plant at Maketu.

Besides producing vermicast from a blend of pulp mill solids and municipal biosolids, both the Kawerau and Tokoroa vermicomposting operations are producing a 'non-biosolids' product for premium customers delivering products to milk plants and kiwifruit pack houses.

Vermicast

Over a thirteen month period our team has proved pulp mill solids from Kinleith Pulp and Paper Mill meet the criteria as an allowed input for organic vermicomposting. This not only demonstrates the high environmental standards of New Zealand pulp and paper mills but also allows us to provide a high quality organic certified vermicast (Table 1) to premium markets at bulk prices.

Table 1. Characteristics of MyNOKE® organic certified vermicast produced from pulpmill solids from Kinleith Pulp and Paper Mill.

Parameter	MyNOKE® organic vermicast
Dry Matter %	40 - 49
Bulk density	745
Organic matter	33.6
Total Carbon %	19.5
Total Nitrogen %	0.65
C/N ratio	29
pH	7.04
Total Phosphorus	1310
Total Sulphur	4430
Total Potassium	804
Total Calcium	71300
Total Magnesium	3420
Total Sodium	869
Total Manganese	259
Total Arsenic	7.0
Total Boron	8
Total Chromium	26
Total Cadmium	0.50
Total Copper	53
Total Lead	38
Total Mercury	0.12
Total Nickel	14.2
Total Zinc	127

Over the past couple of years, the application of vermicast has lead to higher yields in maize (12 to 25%), faster germination of grass, and control of grass grub and facial eczema, and resulted in an increased demand for the product. As there are currently no results on field trials from New Zealand, available studies from overseas are used for explaining the positive effects of humic acids from vermicast on maize:

- Growing far more lateral roots (Zandonadi et al., 2007),
- Growing longer roots (Zandonadi et al., 2007),
- Increasing root density (cm of roots per soil volume) (Roy et al. 2010),
- Growing many times more root hairs (Canellas et al. 2010), and
- Increasing nutrient uptake (H+-ATPase) (Zandonadi et al., 2010).

Increasing soil humus content with the application of vermicast and promoting root development at the same time will increase the water and nutrient holding capacity of the root zone. As a result, these soils, and therefore the pasture and crops, will become less vulnerable to dry periods and less exposed to nutrient leachate. In other words these soils will enable the farmer to utilise the applied mineral fertilisers to grow the targeted yields while minimising nutrient losses from the land.

Outlook for New Zealand

The 150,000 tonnes per year of organic waste currently being vermicomposted and upcycled is only the tip of the iceberg; the potential is estimated to be something in the vicinity of 400,000 tonnes.

Increasing uptake of the MyNoke technology has enormous advantages for New Zealand, both at home and in the global market;

- By returning valuable humus to the land, vermicomposting is a sustainable and cost-effective alternative to traditional land fill.
- Industry adoption of the technology will provide future opportunities for business creation and employment.
- Industry and local government uptake demonstrates strong environmental stewardship, reinforcing determination to maintain New Zealand's clean green image
- Recognition of NZ as the world leader in industrial vermiculture. Interest in the technology from off-shore markets will continue to grow increasing the value of the IP and strengthening the country's 100% Pure image.

The agribusiness sector is a significant driver of New Zealand's economy with agriculture directly accounting for around 5% of GDP. MyNoke is already demonstrating the benefits of applying vermicompost across a number of areas including maize and kiwifruit, but more locally based research is needed.

There also needs to be greater willingness by communities to move away from traditional methods of waste disposal and embrace a more sustainable alternative.

To achieve its full potential will require multi-industry partnerships, research collaborations and the support of regional and central regulators.

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